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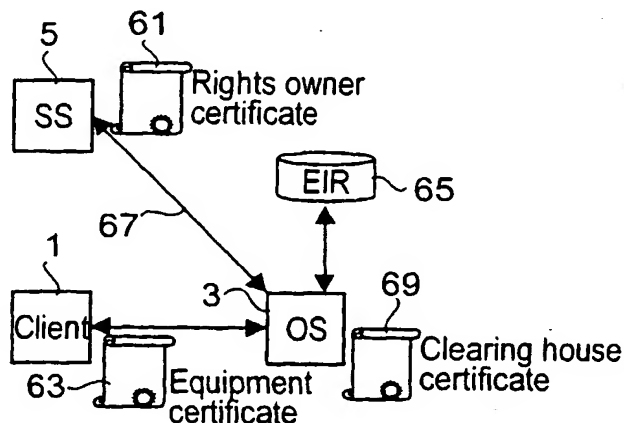
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(54) Title: METHOD AND NETWORK FOR DELIVERING STREAMING DATA



(57) Abstract: In a procedure for delivering streaming media, a Client (1) first requests the media from an Order Server (3). The Order Server authenticates the Client and sends a ticket to the Client. Then, the Client sends the ticket to a Streaming Server (5). The Streaming Server checks the ticket for validity and if found valid encrypts the streaming data using a standardized real-time protocol such as the SRTP and transmits the encrypted data to the Client. The Client receives the data and decrypts them. Copyrighted material adapted to streaming can be securely delivered to the Client. The robust protocol used is very well suited for in particular wireless clients and similar devices having a low capacity such as cellular telephones and PDAs.

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METHOD AND NETWORK FOR DELIVERING STREAMING DATA

TECHNICAL FIELD

The present invention relates to a method of and a network for delivering streaming data from a streaming server to a client and to devices and servers used in delivering streaming data.

BACKGROUND

Digital communication technology offers convenient ways of distributing and copying data, but few means exist of protecting copyright controlled media against unauthorized access or re-distribution.

Some copyright owners have a strong economic interest of protecting their rights and this has lead to an increasing demand for Digital Rights Management (DRM). Generally, the protecting of copyright restricted data transmitted over an insecure channel requires cryptographic mechanisms such as authorization of legal users and encryption of the data. The management of the rights involves establishing trust relations, managing cryptographic keys and charging as well as a specification of the allowed utilization of the media, see e.g. the Internet site <http://www.cselt.it/mpeg/>.

A special difficulty arises in wireless networks or other communication systems exposed to disturbances. Due to the broadcast nature, eavesdropping is potentially very easy, which calls for encryption. But in this case, sensitive authentication information and/or encrypted data may be corrupted by errors during the transmission, which could break or distort the communication. Particularly sensitive data comprise real-time or other streaming media where there is little or no time to repair or re-send corrupted data. Moreover, encryption may have an impact on bandwidth economy, and may computationally overload a thin client such as a cellular telephone.

In the case of severely restricted storage capacity of the receiving device, e.g. a cellular telephone or a so-called "personal digital assistant" (PDA), it is not feasible to include DRM solutions that require large storage capacity. For the same reason it is not suitable or not even possible to have several different DRM solutions in one device. Therefore, a DRM solution should make as much use as possible of some pre-existing security architecture. On the other hand, the restricted environment in such a device also has benefits that should be exploited in a DRM solution. First, the limited storage restrictions are likely to prevent storage of the entire streaming data for later extraction. Second, it is not particularly easy to extract the digital contents from the device in any other shape; i.e. we may consider the device to be, or can with small means be turned into or include a so-called "tamper resistant module".

Most existing DRM solutions are partly based on "security by obscurity", i.e. the methods used are kept secret from the users. This makes it difficult to establish a trust in the solution from the point of view of the users. Second, though this obscurity admittedly makes attacks more difficult, this is only true as long as the obscurity is maintained. History has repeatedly shown that when someone eventually manages to reverse-engineer the solution, or when there is a "leak", security of the system is immediately compromised. Hence, a solution based on publicly known algorithms and protocols as far as possible has great benefits.

STATE OF THE ART

Various methods of content protection and rights management exist, but none is feasible for

transmitting streaming data over an insecure medium exposed to disturbances. Solutions that may have some relevance to this subject are listed and briefly commented in the following.

Commonly used terms and abbreviations include the following:

- DRM (Digital Rights Management): a general framework that may encompass one or more of the following techniques.

- Cryptography, see A. Menezes, P. van Oorschot, and S. Vanstone: "Handbook of Applied Cryptography", CRC Press, 1997 and the Internet site <http://www.cacr.math.uwaterloo.ca/hac/>.

- Watermarking: a process by which a data producer superimposes digital marks on the actual data so that the combined data can be tied to the data producer and so that the marking is resistant to tampering. That is, it should be difficult to completely remove the marks while maintaining a certain "quality" of the data. Watermarking is normally a software technique.

- Copy protection: a process in which data are stored and distributed so as to make copying with a retained quality difficult and/or such that a copy can be traced back to the copier. Full protection usually requires special purpose hardware.

The following protocols for transport of real-time media will be referred to in the description hereinafter:

- RTP (Real Time transport Protocol): IETF Proposed Standard for transport of real-time and streaming data, see Schulzrinne, H., Casner, S., Frederick, R., Jacobson, V., "RTP: A Transport Protocol for Real-Time Applications", IETF Request For Comments RFC 1889, and the Internet site <http://www.ietf.org/rfc/rfc1889.txt>.

- SRTP (Secure RTP or The Secure Real Time Transport Protocol): IETF Draft; security protocol for RTP encompassing encryption using an error-robust, relatively light-weight stream cipher that adds no extra header for the encryption, which makes transmission using SRTP less bandwidth consuming and less sensitive to disturbances compared to e.g. IPsec, see the Internet site <http://search.ietf.org/internet-drafts/draft-ietf-avt-srtp-00.txt>.

- RTSP (Real Time Streaming Protocol): IETF proposed standard for controlling digital streams, much in the same way as a "remote control" for a audio/video device, see the Internet site <http://www.ietf.org/rfc/rfc2326.txt>.

- ROHC (RObust Header Compression): IETF Proposed Standard for compression of e.g. UDP- and RTP-headers (as of Mars 5, 2001), see the Internet sites <http://www.ietf.org/rfc/rfc3095.txt>, <http://www.ietf.org/rfc/rfc3096.txt> and <http://search.ietf.org/internet-drafts/draft-ietf-rohc-rtp-09.txt>. The compression decreases the size of the packet, which reduces the probability of bit errors and makes it more suitable for transport over noisy channels. Since SRTP only encrypts the RTP-payload, ROHC and SRTP are fully compatible.

Standardized solutions

There are several standardization bodies discussing DRM and streaming media, the most mature standards work being the Intellectual Property Management and Protection (IPMP) in Moving Picture Experts Group (MPEG), see the Internet site <http://www.cseit.it/mpeg/standards/ipmp>. MPEG IPMP offers a framework for DRM, but does not include the DRM in itself; it intentionally leaves this open for proprietary solutions.

Open Platform Initiative for Multimedia Access (OPIMA), see the Internet site

<http://drogo.cselt.it/leonardo/opima/>, works on the standardization of a framework for access control, content management and protection tools. It works on downloadable and/or replaceable security for Internet and pay TV applications, but does not address the wireless environment.

IETF (or more precisely its research group, IRTF) is presently setting up a study group for
5 DRM, see the Internet site [http:// www.idrm.org](http://www.idrm.org).

Proprietary solutions

The Microsoft Corporation has its Windows Media Rights Manager 7, see the Internet site
[http://www.microsoft.com/windows/ windowsmedia/en/wm7/drm.asp](http://www.microsoft.com/windows/windowsmedia/en/wm7/drm.asp). This solution gives the
user a possibility to buy a license at a so called clearing house, which can then be used to play a
10 specific media that can be contained on a CD, in an e-mail or a streaming server. The licenses are
tied to the computer, not to the user. The solution aims for the PC market in which both storage
and processing resources are not restricted so that special purpose software can be downloaded
and executed for the playback.

Verance, see the Internet site <http://www.verance.com/verance/technology.html>, claims to
15 have a special wireless DRM, but the system seems only to be based on watermarking. Its
solution does not seem to incorporate encryption of the streaming media.

E-vue, see the Internet site <http://www.e-vue.com>, manufactures MPEG-4 compliant
encoding and authoring tools. No details are given on the site, but its network solutions are
transport protocol independent, which would require inclusion of separate encryption on a higher
20 level.

In the published European patent application EP-1041823 for Toshiba a system for secure
MPEG-4 distribution is disclosed. It does not offer a real DRM solution; it mainly specifies how
to encrypt MPEG-4 and include it in an RTP frame. After the encryption of MPEG-4, an extra
encryption header is added to the payload. The encryption is not done at transport layer and
25 requires special-purpose software and/or hardware.

In the published European patent application EP-1062812 for Intertrust a general DRM
solution is disclosed using a so called secure container which could contain streaming media,
control information and a device for opening the container and extracting cryptographic keys. No
solution is explicitly offered for use in an environment exposed to disturbances. Also, since the
30 keys are in the container, they must be extracted and verified before the streaming can be
continued, which would have a large impact on the real-time requirements.

In the published International patent application WO 2000/52583 for Audible Inc. a
framework is disclosed for authorization of playback device for playing streaming data, but no
reference is made to encryption or ciphering despite the fact that transport over a secure medium
35 is not assumed.

Problems

No DRM solution exists complying with real-time requirements in an environment exposed
to disturbances. The existing solutions also require extensive storage in the client and/or special-
purpose software and/or hardware. Existing DRM solutions are in general proprietary and do not
40 use standard protocols, which require implementations of several DRM solutions in a client. This
may be impossible if the storage capacity is scarce. In addition, the non-disclosure of the

algorithms used makes them less credible to most users.

Another problem associated with existing solutions is that the digital rights are issued for a specific hardware or a small set of hardware devices, e.g. a PC and the possibility to copy the media once to a CD, as opposed to a specific user.

5 SUMMARY

It is an object of the invention to provide a method and device for a robust and secure downloading of streaming data, in particular streaming data protected by copyright.

In the method disclosed herein existing secure transport protocols are used, this giving the benefit of an easy extension to DRM. Since cryptographic protection of the data content is al-
10 ready in place, it is in principle only necessary to extend the protocol by suitable AAA-like (Authentication, Authorization, and Accounting) mechanisms.

In the method and network the following components may be used:

- A robust, lightweight, and secure standardized real-time transport protocol.
- A key distribution mechanism.
- 15 - A charging service.
- A tamper-proof module.

Generally, in the method and network for accessing streaming data, e.g. data protected by copyright, the following events may take place but not necessary in the order given below:

- A request or order from a client or client device for streaming data.
- 20 - Authentication of the client.
- Charging.
- Transmission of the streaming data

The parts interacting in the access of streaming media generally include a Client or client device, an Order Server (OS) and a Streaming Server (SS), the client ordering the media from the
25 Order Server, the Order Server handling the media order and the Streaming Server delivering the streaming media to the Client.

The method and network offer a simple way of distributing material protected by copyright that is adapted to streaming purposes, real-time, possibly interactive data transfer being a special case. By using a robust protocol in the method and network, they are much more suited for
30 wireless clients and heterogeneous environments than existing solutions. The advantage of using a standardized protocol, like SRTP, WTLS, etc., is that it can be implemented in many devices not only for the purpose of Digital Rights Management and therefore can be reused to significantly save storage capacity. This is crucial for client devices having low capacities such as cellular telephones and PDAs.

35 The proposed method and network and the components thereof, even the tamper resistant module which can be included in the client device, are or can be based on open standards and known algorithms. Is often difficult to evaluate other DRM solutions because they are partly based on "security by obscurity", i.e. they may depend on secret procedures or implementations. Since secret algorithms protecting a desired object has a tendency to eventually become public,
40 e.g. the GSM encryption algorithm, DVD encryption algorithms, etc., such solutions are generally considered to be weak in the cryptography region: they are not open to public scrutiny

before implementation. In this case, as in all contemporary public cryptography, the strength of the procedure once evaluated will rely on the keys and the key management.

Another advantage of an open, largely standardized solution is that anyone can use it to protect and distribute his/her data. For instance, a relatively unknown "garage rock group" or an
5 dependent film maker or writer, can in a simple, low cost way, distribute their works to a greater audience in a secure way. One can envision a web-portal hosting producers of such works.

Another advantage, when using the method and network as described herein, for a special-purpose thin client, is that it is much less feasible for a "hacker" to access or store the streaming data than in the case where the receiver is a more open and powerful device such as a personal
10 computer. Though it may still be possible to record an analog output signal, the high quality digital signal should be well protected inside the device. In other words the thin client can for many practical purposes in itself be considered a tamper resistant device. In contrast to the build-your-own environment for personal computers, where it is potentially very simple to bypass a hardware copy protection, it is much easier to obtain security in the more controlled
15 manufacturing of cellular telephones and other portable devices. In fact, manufacturers may obtain security certification of their products.

If this is coupled to an additional DRM module and watermarking, the copyright protection is as good as in any existing solution.

If the Order Server is managed by an operator and the Client has a subscription with this
20 operator, this trust relation can be exercised for authentication and charging purposes. Assuming further that the Streaming Server is a content provider, if an operator and a content provider co-operate with each other, e.g. in the form of a music download portal, the user trusting the operator has a reason to feel more secure against fraud from pirate or spoofing content providers.

The method and network are very flexible in the sense that they can provide different levels
25 of anonymity for the Client depending on the actual implementation. For instance, a totally anonymous solution can be obtained with respect to the Streaming Server, the Order Server, and also possible financial institutions involved, by using anonymous digital payments for access and content payment. On the other extreme end of the spectrum, a very tight connection to the user can be obtained by using an Identity Module and possible watermarking techniques. From the
30 point of view of an operator or a content provider this could be very attractive, since it gives better means for tracking down an unlawful copy to the user who provided the copy.

Since the Streaming Server is housing the media and also can make the final validation of the request before transmitting the data, the Streaming Server has maximum control over the media.

35 The Order Server initiated request also gives an extra benefit in a multicast scenario, e.g. in Internet TV, Video/Radio Broadcasting.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of
40 the methods, processes, instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

While the novel features of the invention are set forth with particularity in the appended claims, a complete understanding of the invention, both as to organization and content, and of the above and other features thereof may be gained from and the invention will be better appreciated from a consideration of the following detailed description of non-limiting embodiments presented hereinbelow with reference to the accompanying drawings, in which:

- Fig. 1 is a general block diagram illustrating an elementary network comprising parts involved in a procedure for delivering streaming media from a Streaming Server to a Client which requests the media from an Order Server,
- 10 - Fig. 2 is a block diagram illustrating the functions of a DRM module of a Client,
- Fig. 3 is a block diagram illustrating optional trust management in the network of Fig. 1,
- Fig. 4 is signalling diagram illustrating steps executed in delivering streaming data,
- Fig. 5 is schematic diagram showing the basic parts of a digital ticket,
- Fig. 6 is a schematic block diagram of a Client showing some basic components thereof, some
15 of which may be optional and some which are alternatives,
- Fig. 7 is a schematic block diagram of an Order Server showing some basic components thereof, some of which may be optional and some which are alternatives, and
- Fig. 8 is a schematic block diagram of a Streaming Server showing some basic components thereof, some of which may be optional and some which are alternatives.

20 DETAILED DESCRIPTION

In a system for ordering and receiving streaming media the interaction of three nodes, a Client 1, an Order Server (OS) 3 and a Streaming Server (SS) 5 which form an elementary network, will now be described, see Fig. 1.

The Client 1 may be a device having a limited processing and storage capacity, e.g. a
25 cellular telephone, a PDA, etc, having conventional manual input means and means for rendering streaming data on a display and/or by a loudspeaker, see also the block diagram of Fig. 6. The Client may optionally have built-in special-purpose DRM tamper-resistant soft- or hardware modules. These modules may be associated with a content provider, a financial institution, or a network operator. The Client may optionally also contain or be connected to an Identity Module
30 (IM), which is a tamper resistant device containing data of the user or a subscription, e.g. a SIM card, a smart card, etc. The IM may be issued by a content provider, a network operator or a third party such as a bank.

The Order Server OS 3 handles the requests from the Client and manages primarily the charging related to the requested media, see also the block diagram of Fig. 7. The Streaming
35 Server 5, see also the block diagram of Fig. 8, houses and manages the streaming data according to conditions set by the Order Server and by the Client.

In a practical situation the Order Server 3 and the Streaming Server SS 5 may be integrated with each other or the tasks described herein that are performed in any of the Order Server and Streaming Server may be allocated to two or more servers.

40 The procedure for obtaining/delivering streaming media starts with the Client 1 presenting a request for a certain object of streaming media to the Order Server 3. This request may also

contain additional information for charging purposes, such as means of payment, credit card number or other monetary information and desired usage of the streaming data, such as duration, format of media, etc. As a response to the Client request, the Order Server 3 may performs tasks like authentication of the Client, charging and preparation for the transfer of the media object
5 requested. The preparation may include QoS (Quality of Service) allocation, which in turn can be associated with the amount of money that the user is willing to pay for the service. The charging may for instance utilize a pre-existing operator-subscriber relation between the Client 1 and the Order Server 3, a credit card number provided by the Client or an anonymous, e.g. electronic, payment system. Alternatively some kind of pre-paying mechanism may be used. If the request is
10 granted, the Streaming Server 5 can stream the media object to the Client over a standardized, robust and secure protocol, such as SRTP, WTLS, etc. or other protocols adapted for this purpose. If the media utilization agreement made so allows, the streaming may be controlled by the user via a protocol like the RTSP. An example of this may be a user at a sports arena who wants to see slow motion replays of an ice hockey match event from several different angles. Such control
15 signalling may need to be authenticated so that only the intended receiver of the stream can control it.

The use of a standardized protocol allows that already existing implementations are reused, which is vital in a Client 1 that is thin, i.e. has limited storage resources.

A robust transport allows a relatively high bit error rate without severely affecting
20 performance of the streaming data.

The streaming data is encrypted in order to make it possible to protect the content of the data from any unauthorized entity getting access thereto.

A high-level protocol for Digital Rights Management will now be described in more detail, with a focus on authorization, key management and charging. As mentioned above, the
25 implementation may make use of special purpose soft- or hardware if such exists. Thus, with reference to Fig. 4 a high-level protocol for Digital Rights Management will now be described. The different steps performed in the protocol are denoted by arrows connecting the Client 1 and the Order Server 3 to each other and arrows connecting the Client and the Streaming Server 5 to each other.

30 Step No. 1, arrow 11: Pre-order

Before the Client 1 actually orders some media object some actions may be taken in communicating between the Client and the Order Server 3, such as finding information on media type, quality, pricing, previewing, etc. Some of this information can possibly also be obtained from the Streaming Server 5, such as lists of available media objects, information whether they
35 can be obtained through the Order Server 3, data types, preview files.

Step No. 2, arrow 12: Order

The Client 1 is involved in communication with the Order Server 3 resulting in a formal order or order-request of some specific media object sent from the Client to the Order Server, e.g. over WAP, HTTP or I-mode, certain rights being associated with the order. The receiving of the
40 order request initiates a sequence of actions that may include exchange of security information, such as authentication of the Client, to be used in the order process and/or in the charging process

and/or in the ticket creation process to be described below.

Step No. 3, arrow 13: Clearing/Charging

The request of step No. 2 also initiates a clearing or charging action, in the normal case where the media object, actually the contents thereof, is charged for. The Client 1 specifies how to pay for the order, in the order message or by some pre-existing agreement, and grants the Order Server 3 the right to charge. The Order Server may optionally be in contact with a clearing house/broker to handle the charging request, such as to check that there is a sufficient amount of money on the user's account, etc.

Step No. 4, arrow 14: Ticket delivery.

10 The Order Server 3 then creates a digitally signed ticket or digitally signed tickets, which it sends back to the Client 1. Such a ticket is a receipt of the order and contains information of the agreement that is necessary for the Client in order to obtain the requested media object from the Streaming Server 5 and to retrieve the contents thereof. This might be information about the Streaming Server and about requested media, cryptographic information, such as a key and other
15 parameters for the streaming data, and usage rights or conditions, i.e. authorization information, for the requested media, e.g. the number of accesses allowed, initiation and expiration time. When receiving the ticket the Client 1 may check that the contents of the ticket coincides with the previously made order.

Step No. 5: Ticket forwarding.

20 To initiate the delivery of the media, the whole ticket or preferably a special part of the ticket is sent from the Client 1 to the Streaming Server 5. Instead, some vital information derived from the received ticket can be sent to the Streaming Server. Optionally, the Client may add information on the aspect of the granted rights to the media that is requested in the media session setup step to be described below. Additional data may also be added to cryptographically tie this
25 information to the Client, via the cryptographic information put into the ticket by the Order Server 3. The Streaming Server verifies the validity of the ticket, e.g. that it still is valid, that it was issued by a legitimate Order Server, that the rights requested by the Client comply with the rights written in the ticket, etc.

Step No. 6: Security setup.

30 The cryptographic information conveyed in the ticket can either be used directly or to obtain extended authentication and/or to derive additional cryptographic information, such as session (SRTP) keys, separate encryption and integrity protection keys, etc. Such keys may be derived, e.g. by using a key management protocol.

Step No. 7: Media session setup.

35 If the ticket is valid, preparation of the actual streaming of media is made. Thus, in order to render the media, certain configuration and manipulation procedures may be necessary, such as configuring codecs, transmitting originating and destination network addresses and ports, fast forward to desired locations, etc. This may be handled by a control protocol, such as the RTSP.

Step No. 8: Streaming/Charging.

40 After all preparations having been made, the Streaming Server 5 starts streaming the media to the Client 1 in accordance with what is ordered. The Client receives the data and decrypts it,

typically "on the fly" in real-time, using the previously obtained key. Optionally, if the agreement allows, the Client 1 may interact with the Streaming Server, using e.g. RTSP, to control the media flow according to what it wishes. Additional charging may be used to allow e.g. volume or time based pricing of media. This type of charging does not require any additional payment from the Client 1, but rather marks consumption of the ticket, by using up its rights. For example, in the case of time based charging, the ticket may contain some amount of time distributed over a certain set of media. The Streaming Server 5 may record the time used and send receipts to the Client. Similarly, for volume based pricing the Streaming Server may record the amount of data streamed instead of time.

Optionally, if the ticket expires, the Client can again contact the Order Server 3, in the case where it wishes to continue the streaming. This re-negotiation may use previously exchanged information, and can therefore be a faster and more lightweight transaction to reduce interruption of the data flow. The protocol then proceeds from step No. 5.

Examples of ticket content

The digital tickets may contain various information, which may depend on the relations between the Order Server 3, the Streaming Server 5 and the Client 1, the existence of a Public Key Infrastructure (PKI), and a hardware identity of the media player, i.e. of the Client. The tickets could contain information on the requested media, the usage conditions allowed and they can also act as receipts or vouchers for the associated economic transaction.

1. If the Order Server 3 and the Client 1 have an operator/subscriber relation, one ticket may contain the session key, e.g. the SRTP key, encrypted with some secret data manifesting the relation, such as a cryptographic key known to the Order Server and which may be contained in an Identity Module in the Client. Another ticket may contain the session key encrypted with a public key belonging to the Streaming Server 5. The former ticket may act as a receipt for the Client whereas the latter ticket may act as a token to be shown or passed to the Streaming Server at the final request for the media.

2. If the Client 1 has a known public key, the Order Server 3 may leave the generation of the session key to the Streaming Server 5, and the tickets may not carry this information.

In either case, tickets may optionally contain the identity of the playing device, i.e. of the Client, such as an IP address, a hardware identity etc. Tickets may contain a time stamp, a counter value or something e.g. to indicate the freshness of a ticket or to prevent unauthorized replay. A ticket sent from the Order Server 3 aimed for the Streaming Server 5 may contain a Client identifier, with which the Streaming Server may e.g. watermark the media. It can provide anonymity to the Client except in the case of copyright infringement, in which case the Order Server may reveal the identity connected to this identifier.

Also the tickets may be optionally digitally signed by the Order Server, e.g. with a public key belonging to the Order Server for integrity protection, e.g. to protect against spoofing.

A ticket may e.g. contain the following fields, see Fig. 5:

- A field 21 for general parameters. These parameters may contain information that both the Client 1 and the Streaming Server 5 have to receive, e.g. identities, information on rights, authentication and encryption algorithms.

- A field 22 for Streaming Server specific parameters. The contents of is field cannot be accessed by the Client and may contain information necessary for the Streaming Server 5 to establish a cryptographic relation with the Client 1. A mandatory part is a cryptographic key encrypted by the Order Server 3, that can be decrypted by the Streaming Server. This can be done using the Streaming Server public key or a key pre-shared between the Streaming Server and the Order Server. The same mandatory key is also included in the Client parameters, see below. A special embodiment of the mandatory key is the SRTP key or a key that can be used to derive the SRTP key.
- A field 23 for Client specific parameters. This field may contain information necessary for the Client 1 to establish a cryptographic relation with the Streaming Server 5. As above, a mandatory part is a cryptographic key encrypted by the Order Server 3 that can be decrypted by the Client. This can be done by using the Client public key or key pre-shared between the Client and the Order Server.
- A field 24 for Authentication information. This fields contains information for Streaming Server 5 and the Client 1 for verifying the validity of the ticket. Either the field contains a signature made with the Order Server public key which both the Streaming Server 5 and the Client can verify or it contains two parts, one part of which can be verified by the Streaming Server and another part of which can be verified by the Client. The latter can be achieved using a Message Authentication Code using keys pre-shared by the Order Server and the Streaming Server, and by the Order Server and the Client, respectively.

It can be observed that using the procedures described above it is very easy to tie access rights for the media to the user, i.e. an identity, rather than to the hardware to which the downloading is made. This can be accomplished, for instance, by using an Identity Module, such as an SIM card in a mobile terminal, involved in the transactions. Alternatively a credit card number can serve this purpose. By using anonymous, electronic, payments, the access is tied to the user without revealing his identity.

To further enhance security against unlawful copying or playback, the controlled environment in a mobile terminal can be easily extended by an optional hardware security module. Such a module can prevent or control transmission of the data to an external digital device and/or put a watermark to the signal based on the user identity so that the user can be traced. An example of such a module will now be described.

The DRM module

A DRM module, such as a special purpose tamper resistant integrated circuit or a physically protected device, may be optionally included in the Client 1 to make it even more difficult to prevent unlawful access to the media. In the block diagram of Fig. 2 the functions of such a module 41 for an SRTP based solution are illustrated.

The module must at least (1) contain some secret data K1 stored in a secure memory 43, such as a cryptographic key, which may be a resource common to or stored in the IM. This data can be utilized to tie the usage rights to a subscriber identity or a device. It may also (2) include a device F1, 45 for performing a decryption algorithm or cryptographic one-way function, which takes as input the secret data K1 delivered from the secure memory 43 on a line 44 comprising an

interface A, 46, and the encrypted SRTP key, as provided on an input line 47 of the module 41, and produces as output the decrypted SRTP key on a line 49. As a third version (3) the module 41 may also contain the entire SRTP decryption functionality, as illustrated by the block 51, to which the decrypted SRTP key is provided on the line 49. The SRTP decryption block 51 receives the data of the encrypted media stream on a line 52 input to the module and delivers a decrypted stream of data on a line 52 output of the module 41. In this way, the SRTP key, which passes in clear text over a interface B at 53 in the line 49 is entirely protected within the module 41. In this case it may be advantageous to allow an interface C, 55 at an input line 57 to the module to insert a key into the interface B 53, so that this SRTP implementation can be reused for other purposes. The function F1 in the block 45 will in such a case prevent unauthorized use, when somebody attempts to override the DRM functionality.

For example, the use of the DRM module 41 can be as follows. First, the digital ticket is received by the Client 1 and the streaming session is set up, Steps Nos. 5 - 7.

- The encrypted SRTP key is provided to the DRM module 41 on the input line 47. The key is received by the function block F1 45 that uses it and the secret information K1 stored in the secure memory 43 to produce the plain text SRTP key that is provided to the line 49 and appears on the B interface 53 and is accessed by the SRTP decryption block 51.
- The incoming encrypted SRTP stream can now be provided to the DRM module 41 on the input line 52, is decrypted by the block 51 and the plain text RTP packets are delivered from the decryption block on the output line 52'.
- It is not possible to extract the keys available on the B interface 53 outside the DRM module 41. However, it is possible to enter plain text SRTP keys on the C interface 55 in input line 57 and thereby use the DRM module also for decrypting SRTP streams when the plain text SRTP key is known. It can be observed that decrypting and encrypting according to the SRTP can be done in the same way and that the DRM module 41 thus can be used for encrypting as well as decrypting in the case where the plain text SRTP key is known.

Though less likely, in the most extreme case, not shown, the Client could be a wireless device with an antenna input and an e.g. analog audio output, where everything connected in-between is implemented in a tamper resistant way.

30 Trust management

To provide trust management in the case where there is no pre-existing relation, and/or authentication between the communicating parties the following optional "certificate" structure can be used, as illustrated by the block diagram of Fig. 3. With certificate is meant some data confirming the identity and/or rights of a certain party or equipment.

35 The Order Server 3 may want to ensure that the Streaming Server 5 has the rights to the streaming media for which the Order Server is charging, and this may be demonstrated by utilizing a certificate 61 issued by a rights owner. The ownership of this certificate may be demonstrated to the Order Server at appropriate time/times. This certificate may also be obtained dynamically, during the order process.

40 The Streaming Server 5, on the other hand, may want to know that the Client 1 has lawful equipment to handle the media without violating the given rights, and also that the equipment is

not malfunctioning and/or stolen or otherwise illegally obtained. For this purpose the Client's equipment may optionally contain a certificate 63 or token issued by the manufacturer of the equipment to prove e.g. that it is original equipment, that it contains the relevant DRM module 41, etc. If the Order Server 3 is managed by an operator, the Order Server may check whether the equipment is registered in a database, which keeps track of stolen, unauthorized or defective equipment, such as the GSM network's Equipment Identity Register (EIR) 65, see "GSM System Survey", Ericsson Student Text, EN/LZT 123 3321 R3A.

The Streaming Server 5 may also want to protect from a "false Order Server" attack, wherein a Client 1 is claimed to have paid for a certain media object without having done so. This may be resolved by the mechanisms described above, if an established agreement between the Order Server 3 and the Streaming Server exists, see the arrow 67 of Fig. 3. Such an agreement can be created by e.g. the use of a Clearing house certificate, see item 69, issued by a party that the Streaming Server trusts, and which indicates that the Order Server should be a trusted party. This certificate may also be obtained dynamically, during the order process.

An example will now be described in which a preferred method is executed.

The Client 1 finds, by surfing on the World Wide Web from a wireless terminal, an offer to buy/view a rock video-clip for limited use, e.g. a time period of 30 minutes. The Client also decides to pay a little extra for HiFi-quality audio. The Client specifies the desired media and usage and agrees on the price. The Order Server 3 receives this information and charges, based on a previous contractual agreement with the Client such as e.g. a telephone or Internet subscription. The Order Server also checks the status with the Streaming Server 5 to see that the requested media can be delivered according to the specified conditions or that the Streaming Server reserves capacity therefor. The Order Server produces a ticket and sends it, encrypted and signed/authenticated, to the Client with the following contents: a reference to the requested data, e.g. a file name, a session encryption key for the SRTP stream, a freshness token to protect against replay, information on the validity period, i.e. 30 min, QoS data, and the identity and address of the Client and the Streaming Server. From the ticket, the Client 1 extracts the data, most importantly the session key, and forwards it in encrypted shape to the Streaming Server 5 along with the authorization of the Order Server, i.e. the signature/authentication tag of the Order Server. The Streaming Server extracts the ticket content, checks freshness and authorization of the Client made by the Order Server 3. Finally, the Streaming Server starts to send the encrypted stream to the Client. The DRM module 41 in the Client produces a decrypted stream, as described with reference to Figs. 1, 2 and 4, which is played on the device. Halfway through the video, the Client is disturbed by a local noise. Over RTSP, the Client "rewinds" the stream a bit, and restarts the media stream sent from the Streaming Server 5 from that point. The Client may need to accompany the control request with the ticket, or information derived therefrom, so that the Streaming Server can check the validity. The RTSP messages may also be authenticated by the Client, so that no one else can take control over the streaming, or do denial of service.

Additionally, the Streaming Server 5 may confirm the transaction of the media with the Order Server 3 so that the charging is not done until the actual media has been delivered. Alternatively, acknowledgments of delivery may be sent from the Streaming Server to the Order

Server prior to or during the transaction, to allow flexible charging, e.g. proportional to the time spent or to the amount of data actually delivered.

While specific embodiments of the invention have been illustrated and described herein, it is realized that numerous additional advantages, modifications and changes will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details, representative devices and illustrated examples shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents. It is therefore to be understood that the appended claims are intended to cover all such modifications and changes as fall within a true spirit and scope of the invention.

CLAIMS

1. A method of secure downloading of streaming data to a client having an identity, **characterized by** the sequential steps of:
 - the client ordering from an order server the delivery of streaming data,
 - 5 - the order server receiving the order, and in response to the order, authenticating the client and transmitting a digital ticket to the client,
 - the client transmitting at least part of the digital ticket client to a streaming server, the part comprising a request to download the streaming data to the client,
 - the streaming server encrypting the streaming data using a robust and secure transport protocol
 - 10 and transmitting the encrypted streaming data, and
 - the client receiving the encrypted streaming data and decrypting them.
2. A method according to claim 1, **characterized by** transmitting, in the step of transmitting the digital ticket, in the digital ticket cryptographic information to be used by the streaming server in the step of encrypting the streaming data and by the client in the step of
- 15 decrypting the streaming data.
3. A method according to claim 2, **characterized in** that said cryptographic information is transmitted in way making it impossible for the client to access the cryptographic information, in particular transmitting the cryptographic information in an encrypted form.
4. A method according to claim 1, **characterized by** the additional step of transferring, in
- 20 the step of transmitting the order, charging information from the client to the order server.
5. A method according to claim 1, **characterized in** that the robust and secure transport protocol includes a standardized real-time protocol.
6. A method according to claim 1, **characterized by** the additional step of selecting the robust and secure transport protocol to be insensitive to occasional errors during transmission, in
- 25 particular to be capable of correcting occasional errors and/or so that occasional errors have little effect on the transmitted data, in particular errors including delay or distortion.
7. A method according to claim 1, **characterized in** that the transport protocol includes the Secure Real Time Protocol.
8. A method according to claim 1, **characterized in** that the transport protocol includes the
- 30 Robust Header Compression protocol.
9. A method according to claim 1, **characterized by** the additional step of storing the identity of the client in a tamper resistant identity module.
10. A method according to claim 7, **characterized by** the additional step of storing also the usage rights of the user in the tamper resistant identity module.
- 35 11. A method according to claim 1, **characterized in** that in the transmitting, the transmitting is made wirelessly.
12. A method according to claim 1, **characterized by** the additional step of associating the identity with a user.
13. A method according to claim 1, **characterized by** the additional step of associating the
- 40 identity with an IP address of a user.
14. A client device for communication with an order server and a streaming server for

secure downloading of streaming data from the streaming server to the client device, which has an identity, **characterized by**:

- ordering means for preparing and transmitting an order to the order server for delivery of an object of streaming data,
- 5 - ticket receiving means for receiving a digital ticket from the order server,
- ticket forwarding means for forwarding at least part of the digital ticket client to the streaming server, the part comprising a request to download the object of streaming data to the client, and
- streaming data receiving means for receiving streaming data of the object.

15 15. A client device according to claim 14, **characterized in** the streaming data receiving means comprise or are connected to means for decrypting the received streaming data.

16. A client device according to claim 15, **characterized in** that the ticket receiving means are arranged to extract from the digital ticket cryptographic information to be used for decrypting streaming data received by streaming data receiving means.

17. A client device according to claim 15, **characterized in** that the ticket forwarding
15 means are arranged to forward in said at least part of the digital ticket cryptographic information to be used by the streaming server for encrypting streaming data to be transmitted to the client device.

18. An order server for communication with a client device for secure downloading of streaming data from a streaming server to the client device, which has an identity, **characterized**
20 **by**:

- order receiving means for receiving from the client device an order of an object of streaming data,
- ticket means for preparing a digital ticket and transmitting the digital ticket to the client device, the ticket containing information on the ordered object of streaming to be forwarded by the client
25 device to the streaming server.

19. An order server according to claim 18, **characterized in** that the ticket means are arranged to prepare the ticket to contain cryptographic information to be used by the client device and/or the streaming server in the secure downloading of the streaming data of the ordered object.

20. An order server according to claim 18, **characterized by** charging means connected to
30 the order receiving means for charging the client device or a user associated therewith for the order object of streaming data.

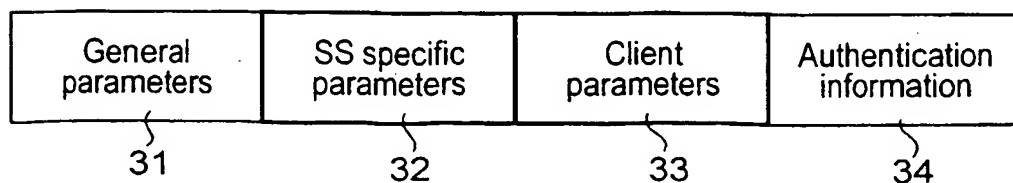
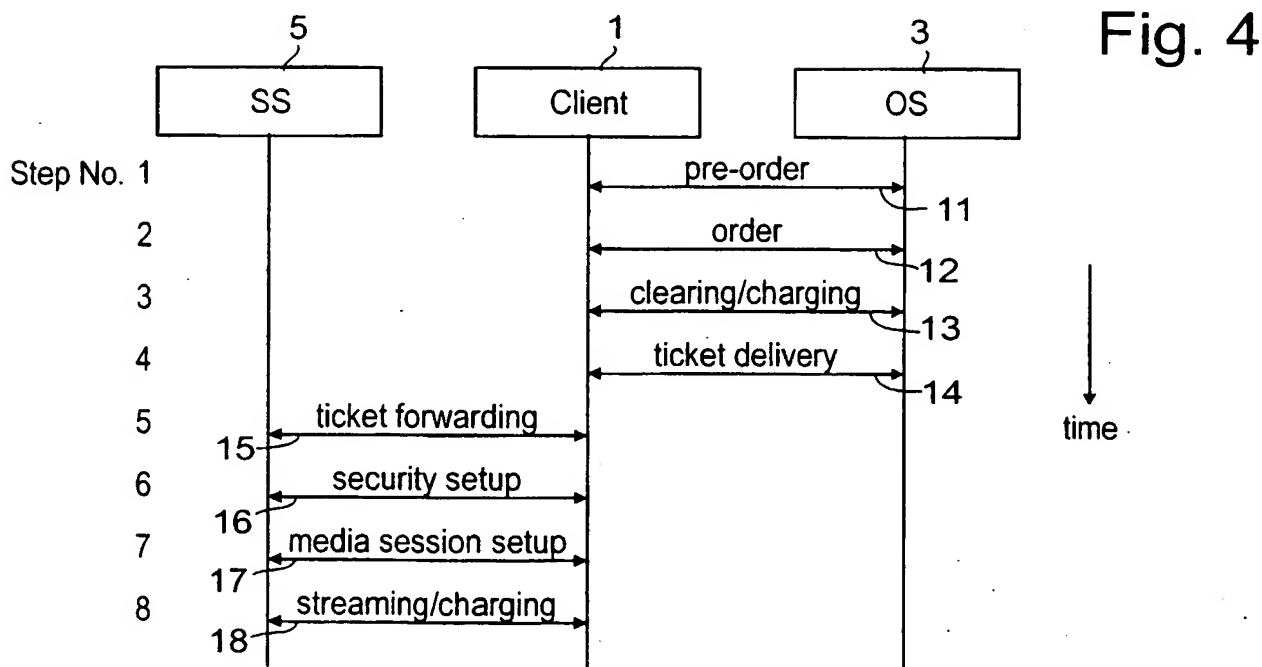
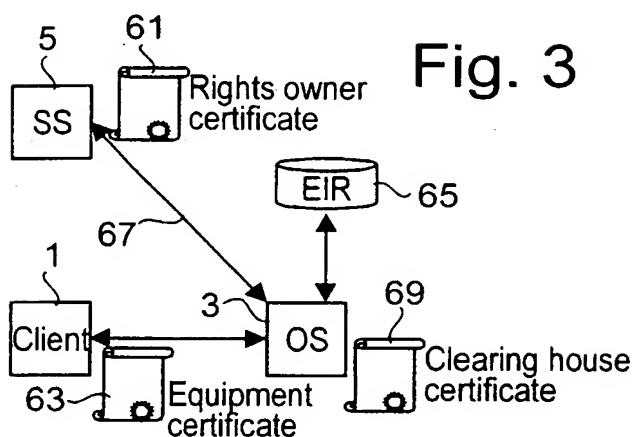
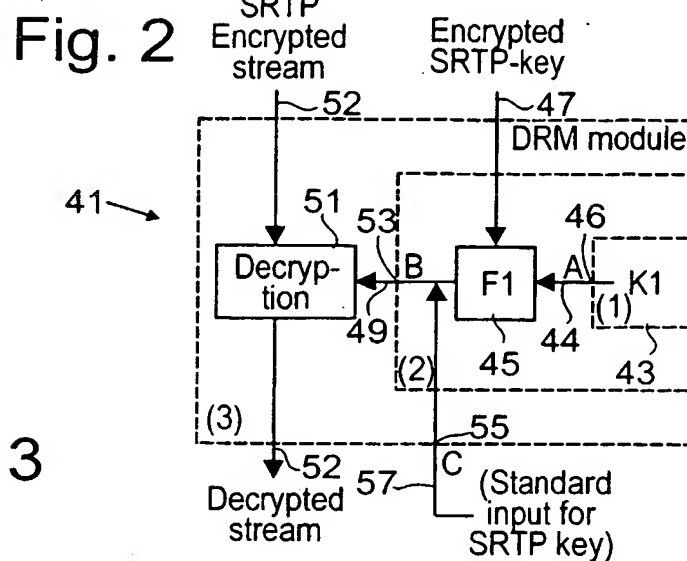
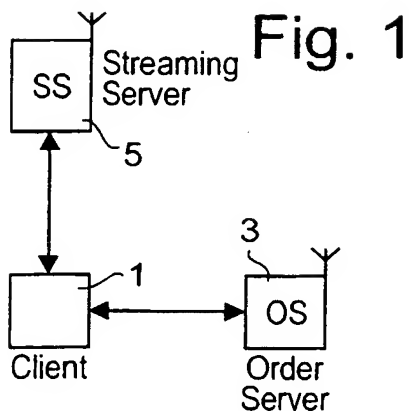
21. A streaming server for communication with a client device for secure downloading of streaming data from the streaming server to the client device, which has an identity, **characterized by**:

- 35 - storage means for storing a plurality of objects of streaming data,
- ticket receiving means for receiving a ticket from the client device, the ticket containing information at least partly derived from a ticket transmitted from an order server to the client device,
- extracting means connected to the ticket receiving means for extracting information from the
40 ticket, the extracted information comprising an indication of an object of streaming data stored in the streaming server, and

- session download means connected to the extracting means for downloading the indicated object of streaming data to the client device.

22. A streaming server according to claim 21, **characterized in** that the extracting means are arranged to extract information of a key and that the session download means are arranged to
5 encrypt the streaming data in the downloading operation.

23. A network for secure downloading of streaming data, **characterized by** a client device according to claim 14, an order server means device according to claim 18 and a streaming server according to claim 21.



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Fig. 6

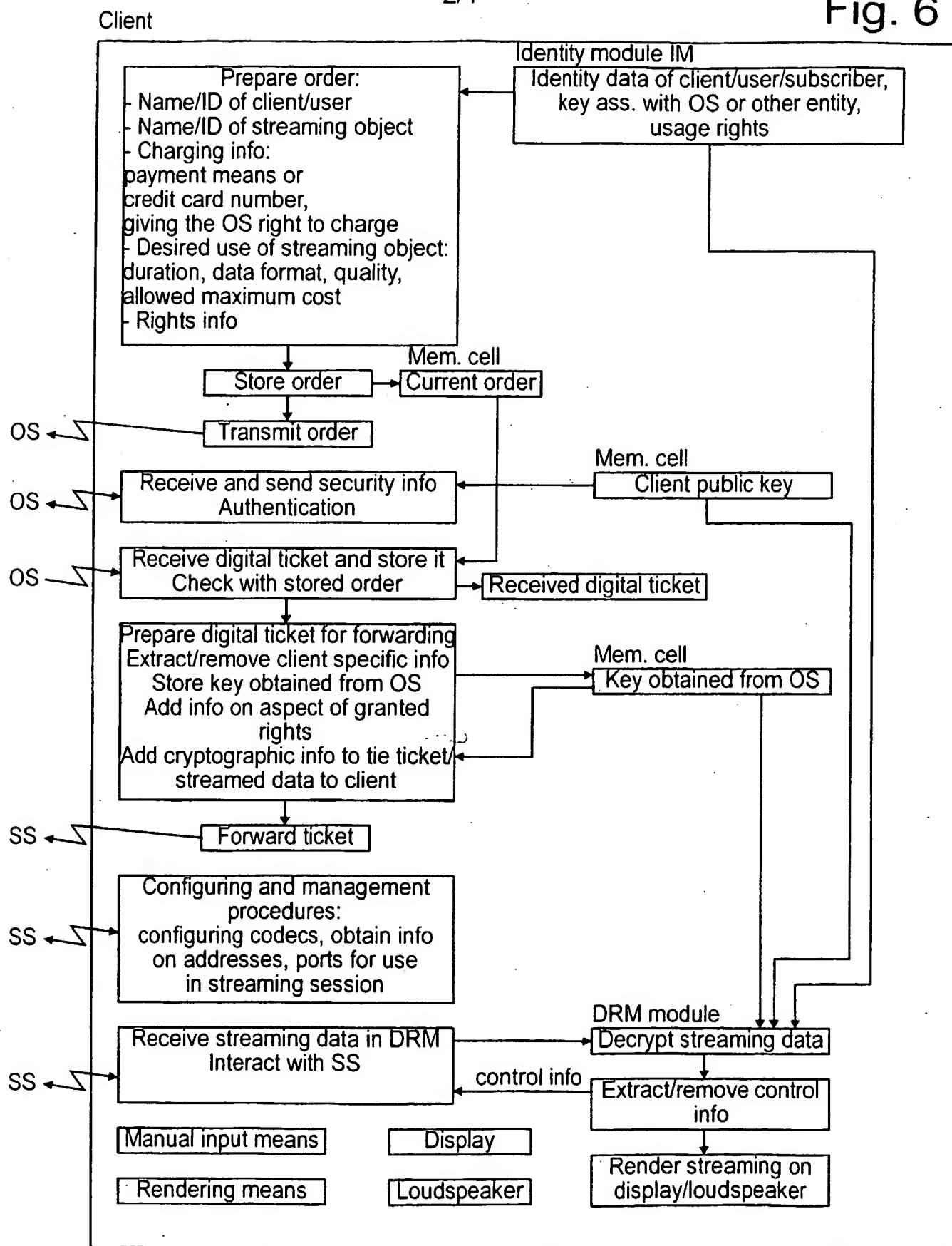
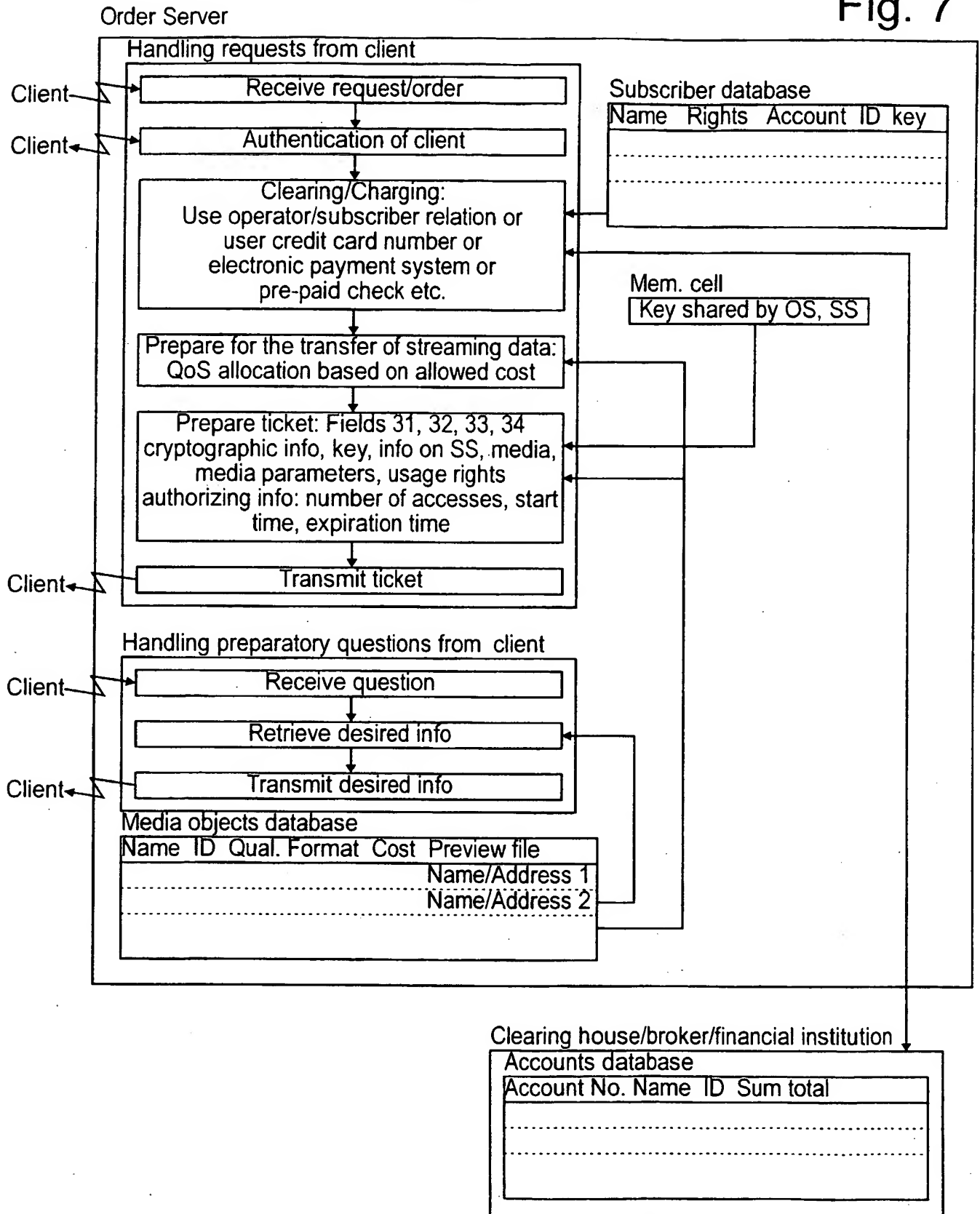
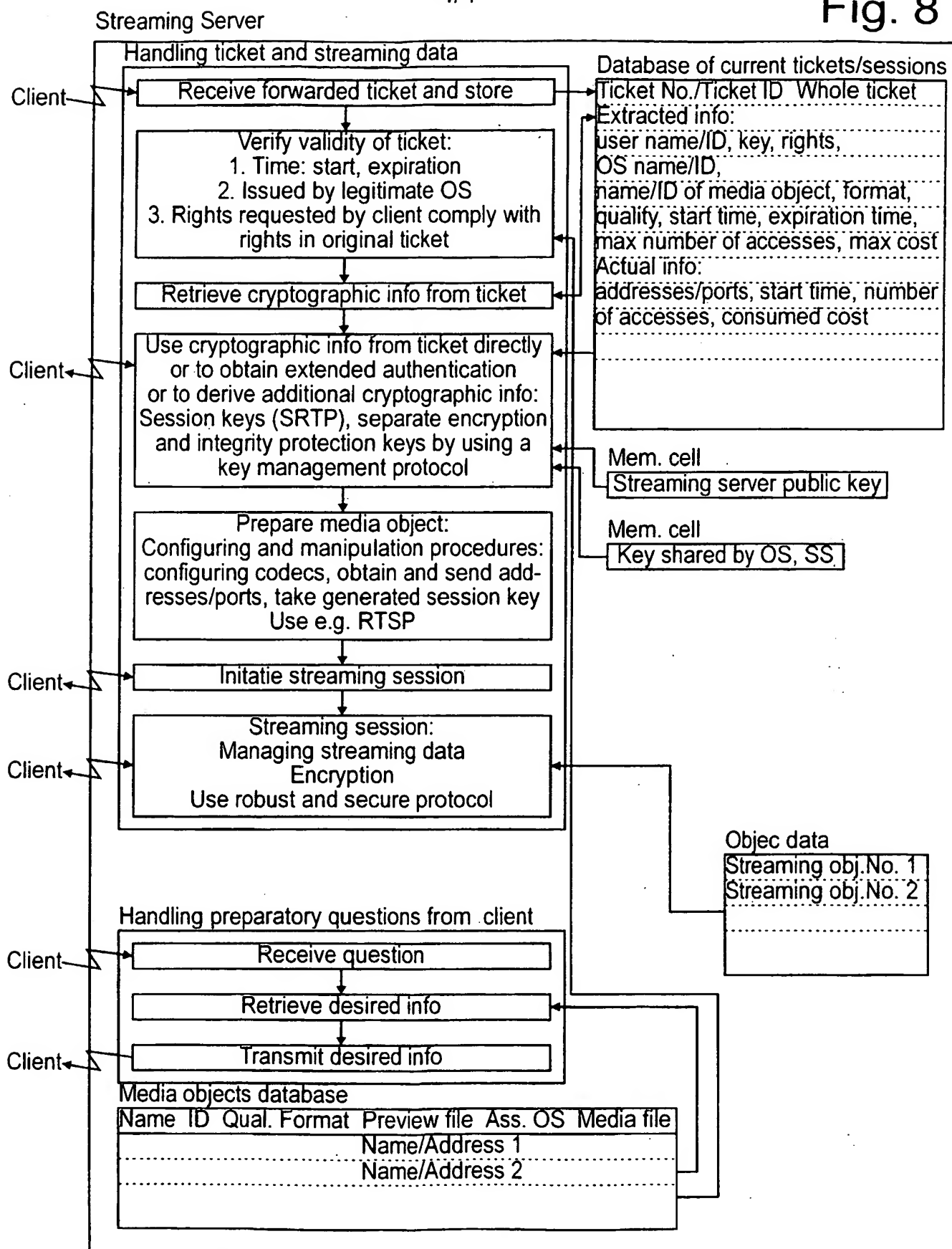


Fig. 7



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Fig. 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 02/00721

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04L 29/06, G06F 1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G06F, H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 0199374 A2 (APPLE COMPUTER, INC), 27 December 2001 (27.12.01), page 2, line 32 - page 3, line 24, claim 1, abstract --	1-23
P,A	WO 0177800 A2 (MEDIA LOGIC SYSTEMS LTD), 18 October 2001 (18.10.01), page 5, line 15 - page 7, line 10, claims 1-4, abstract --	1-23
P,A	EP 1193920 A2 (MICROSOFT CORP), 3 April 2002 (03.04.02), column 1, line 55 - column 2, line 21, abstract -- -----	1-23

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

06/07/02

International application No.

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Patent document cited in search report			Publication date	Patent family member(s)		Publication date
WO	0199374	A2	27/12/01	NONE		
WO	0177800	A2	18/10/01	AU	4669701 A	23/10/01
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